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# APPARATUS AND METHOD FOR PROPULSION

of which the following is a specification:

## BACKGROUND OF THE INVENTION

1. Field of the Invention:

This invention relates to methods and apparatus for providing propulsion, in particular methods and apparatus for providing propulsion using a scattered electron beam.

2. Description of the Related Art

The attractive gravitational force has been the subject of investigation for centuries. Traditionally, gravitational attraction has been investigated in the field of astrophysics applying a large scale perspective of cosmological spacetime, as distinguished from currently held theories of atomic and subatomic structure. However, gravity originates on the atomic scale. In Newtonian gravitation, the mutual attraction between two particles of masses $m_1$ and $m_2$ separated by a distance $r$ is

$$\mathbf{F} = G\frac{m_1 m_2}{r^2} \tag{23.1}$$

where $G$ is the gravitational constant, its value being $6.67\,X\,10^{-11}\,Nm^2kg^{-2}$. Although Newton's theory gives a correct quantitative description of the gravitational force, the most elementary feature of gravitation is still not well defined. What is the most important feature of gravitation in terms of fundamental principles? By comparing Newton's second law,

$$\mathbf{F} = m\mathbf{a} \tag{23.2}$$

with his law of gravitation, we can describe the motion of a freely falling object by using the following equation:

$$m_i\mathbf{a} = m_g\frac{GM_{\oplus}}{r^3}\mathbf{r} \tag{23.3}$$

where $m_i$ and $m_g$ represent respectively the object's inertial mass (inversely proportional to acceleration) and the

gravitational mass (directly proportional to gravitational force), $M_{\oplus}$ is the gravitational mass of the Earth, and $r$ is the position vector of the object taken from the center of the Earth. The above equation can be rewritten as

$$a = \frac{m_g}{m_i}\left(\frac{GM_{\oplus}}{r^2}\right) \qquad (23.4)$$

Extensive experimentation dating from Galileo's Pisa experiment to the present has shown that irrespective of the object chosen, the acceleration of an object produced by the gravitational force is the same, which from Eq. (23.4) implies that the value of $m_g / m_i$ should be the same for all objects. In other words, we have

$$\frac{m_g}{m_i} = \text{universal constant} \qquad (23.5)$$

the equivalence of the gravitational mass and the inertial mass- the fractional deviation of Eq. (23.5) from a constant is experimentally confirmed to less $1 X 10^{-11}$ [1]. In physics, the discovery of a universal constant often leads to the development of an entirely new theory. From the universal constancy of the velocity of light $c$, the special theory of relativity was derived; and from Planck's constant $h$, the quantum theory was deduced. Therefore, the universal constant $m_g / m_i$ should be the key to the gravitational problem. The theoretical difficulty with Newtonian gravitation is to explain just why relation, Eq. (23.5), exists implicitly in Newton's theory as a separate law of nature besides Eqs. (23.1) and (23.2). Furthermore, discrepancies between certain astronomical observations and predictions based on Newtonian celestial mechanics exist, and they apparently could not be reconciled until the development of Einstein's theory of general relativity which can be transformed to Newtonian gravitation on the scale in which Newton's theory holds.

Einstein's general relativity is the geometric theory of gravitation developed by Albert Einstein, whereby he intended to incorporate and extend the special theory of relativity to accelerated frames of reference. Einstein's

theory of general relativity is based on a flawed dynamic formulation of Galileo's law. Einstein took as the basis to postulate his gravitational field equations a certain kinematical consequence of a law which he called the "Principle of Equivalence" which states that it is impossible to distinguish a uniform gravitational field from an accelerated frame. However, the two are not equivalent since they obviously depend on the direction of acceleration relative to the gravitation body and the distance from the gravitating body since the gravitational force is a central force. (In the latter case, only a line of a massive body may be exactly radial, not the entire mass.) And, this assumption leads to conflicts with special relativity. The success of Einstein's gravity equation can be traced to a successful solution which arises from assumptions and approximations whereby the form of the solution ultimately conflicts with the properties of the original equation, no solution is consistent with the experimental data in the case of the possible cosmological solutions of Einstein's general relativity. All cosmological solutions of general relativity predict a decelerating universe from a postulated initial condition of a "Big Bang" expansion [2]. The astrophysical data reveals an accelerating cosmos [3] which invalidates Einstein's equation. It has been shown that the correct basis of gravitation is not according to Einstein's equation; instead the origin of gravity is the relativistic correction of spacetime itself which is analogous to the special relativistic corrections of inertial parameters-- increase in mass, dilation in time, and contraction in length in the direction of constant relative motion of separate inertial frames. On this basis, the observed acceleration of the cosmos is predict as given in the Cosmology Section of Mills [4]. Furthermore, Einstein's general relativity is a partial theory in that it deals with matter on a cosmological scale, but not an atomic scale. All gravitating bodies are composed of matter and are collections of atoms which are composed of fundamental particles such as electrons, which are leptons, and quarks which make up protons and neutrons. Gravity

originates from the fundamental particles.

As a result of the erroneous assumptions and incomplete or erroneous models and theories, the development of useful or functional systems and structures requiring an accurate understanding of atomic structure and the nature of gravity on the atomic scale have been inhibited. On a scale of gravitating bodies, the Theory of General Relativity is correct experimentally; however, it is incompatible with observation of an acceleration expansion on a cosmological scale, and is incompatible with the current atomic theory of quantum mechanics. And, the Schrodinger equation upon which quantum mechanics is based does not explain the phenomenon of gravity and, in fact, predicts infinite gravitational fields in empty vacuum. Thus, advances in development of propulsion systems which function according to gravitational forces on the atomic scale are prohibited.

## SUMMARY OF THE INVENTION

### Overview of the Novel Theoretical Basis

While the inventive methods and apparatus described in detail further below may be practiced as described, the following discussion of a novel theoretical basis of the invention is provided for additional understanding.

A novel atomic theory is disclosed in R. Mills, The Grand Unified Theory of Classical Quantum Mechanics, January 2000 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com which are incorporated herein by this reference. The Schwarzschild metric gives the relationship whereby matter causes relativistic corrections to spacetime that determines the curvature of spacetime and is the origin of gravity. The correction is based on the boundary conditions that no signal can travel faster that the speed of light including the gravitational field that propagates following particle production from a photon wherein the particle has a finite gravitational velocity given by Newton's Law of Gravitation. It is possible to give the electron a spatial

velocity function having negative curvature and, therefore, cause the electron to have a positive inertial mass but a negative gravitational mass. An engineered spacecraft is disclosed.

Propulsion Methods and Means

The present invention of a propulsion device comprises a source of matter, a means to give the matter a spatial velocity function having negative curvature which causes the matter to react to a gravitation body such that it has a negative gravitational mass, and a means to produce a force on the matter in opposition to the repulsive gravitational force between the matter and the gravitating body. The force on the matter is applied in the opposite direction of the force of the gravitating body on the matter. This second force is provided by one or more of an electric field, a magnetic field or an electromagnetic field. The repulsive force of the gravitating body is then transferred to the source of the second force which further transfers the force to an attached structure to be propelled. In response to the applied force, the matter produces useful work against the gravitational field of the gravitating body.

In one embodiment the propulsion means comprises a means to inject particles such as electrons which serve as the matter. It is possible to elastically scatter electrons of an electron beam from atoms such that electrons having a spatial velocity function having negative curvature (hyperbolic electrons) emerge. The emerging beam of hyperbolic electrons experience a force away from a gravitating body (e.g. the Earth) and the beam will tend to move upward (away from the Earth). To use this invention for propulsion, the upward force of the electron beam is transferred to a negatively charged plate. The Coulombic repulsion between the beam of electrons and the negatively charged plate causes the plate (and anything connected to the plate) to lift.

## BRIEF DESCRIPTION OF THE FIGURES

These and further features of the present invention will be better understood by reading the following Detailed Description of the Invention taken together with the Drawing, wherein:

FIGURE 1 is a saddle;

FIGURE 2 is a pseudosphere;

FIGURE 3 is a propulsion device according to the present invention;

FIGURE 4 is the magnitude of the velocity distribution ($|v_\phi|$) on a two dimension sphere along the z-axis (vertical axis) of a hyperbolic electron;

FIGURE 5 is a cutaway of the magnitude of the velocity distribution ($|v_\phi|$) on a two dimension sphere along the z-axis (vertical axis) of a hyperbolic electron;

FIGURE 6 is an propulsion device driven by hyperbolic electrons;

FIGURE 7 is a drawing of an propulsion apparatus according to one embodiment of the present invention to give electrons a spatial velocity function having negative curvature and, therefore, cause the electrons to have a negative gravitational mass;

FIGURE 8 is a schematic of the hyperbolic path of a hyperbolic electron of mass $m$ in an inverse-square repulsive field of a gravitating body comprised of matter of positive curvature of the velocity surface of total mass $M$;

FIGURE 9 is a schematic of the helical motion of a hyperbolic electron in a synchrotron orbit in the xy-plane with a repulsive gravitational force along the +z axis which is transferred to the capacitor, and

FIGURE 10 is a schematic of the forces on a spinning craft which is caused to tilt.

## DETAILED DESCRIPTION OF THE INVENTION

The theoretical background of the present invention is given the book by Mills [4] which is herein incorporated by

reference. The equations numbers given below refer to the corresponding equations of Mills book.

The provision of the equivalence of inertial and gravitational mass by the Mills theory of fundamental particles wherein spacetime is Riemannian due to its relativistic correction with particle production permits the correct derivation of the General Theory. In the case of ordinary matter (an example of an extraordinary state of matter called a hyperbolic electron is given *infra*), the nature of chemical bonding is electric and magnetic, and the angular momentum of each bound electron is always $\hbar$ independent of material such as wood or metal. The angular momentum with a central field is given by Eq. (1.57). In this case, each infinitesimal point of the electron orbitsphere (given in Chp. 1 of Mills book as a solution of the electron wavefunction with a nonradiative boundary constraint) of mass $m_i$ is the inertial mass according to the inertial angular momentum. It also is the gravitational mass according to the gravitational angular momentum. The inertial and gravitational mass of electrons and nucleons in ordinary matter are equivalent.

The provision of the two-dimensional nature of matter permits the unification of atomic, subatomic, and cosmological gravitation. The unified theory of gravitation is derived by first establishing a metric. A space in which the curvature tensor has the following form:

$$R_{\mu\nu.\alpha\beta} = K \cdot (g_{\nu\alpha} g_{\mu\beta} - g_{\mu\alpha} g_{\nu\beta}) \qquad (26.1)$$

is called a space of constant curvature; it is a four-dimensional generalization of Friedmann-Lobachevsky space. The constant $K$ is called the constant of curvature. *The curvature of spacetime results from a discontinuity of matter having curvature confined to two spatial dimensions. This is the property of all matter as an orbitsphere.* Consider an isolated orbitsphere and radial distances, $r$, from its center. *For $r$ less than $r_n$ there is no mass; thus, spacetime is flat or Euclidean.* The curvature tensor applies to all space of the inertial frame considered; thus, for $r$ less than $r_n$, $K = 0$. At $r = r_n$ there exists a discontinuity of mass of the orbitsphere.

This results in a discontinuity of the curvature tensor for radial distances greater than or equal to $r_n$. The discontinuity requires relativistic corrections to spacetime itself. It requires radial length contraction and time dilation that results in the curvature of spacetime. The gravitational radius of the orbitsphere and infinitesimal temporal displacement in spacetime which is curved by the presence of the orbitsphere are derived in the Gravity Section of Mills [4].

The Schwarzschild metric gives the relationship whereby matter causes relativistic corrections to spacetime that determines the curvature of spacetime and is the origin of gravity. The correction is based on the boundary conditions that no signal can travel faster that the speed of light including the gravitational field that propagates following particle production from a photon wherein the particle has a finite gravitational velocity given by Newton's Law of Gravitation. The separation of proper time between two events $x^{\mu}$ and $x^{\mu}+dx^{\mu}$ given by Eq. (23.38), the Schwarzschild metric [5-6], is

$$d\tau^2 = \left(1-\frac{2Gm_0}{c^2 r}\right)dt^2 - \frac{1}{c^2}\left[\left(1-\frac{2Gm_0}{c^2 r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \quad (26.2)$$

Eq. (26.2) can be reduced to Newton's Law of Gravitation for $r_g$, the gravitational radius of the particle, much less than $r_\alpha^*$, the radius of the particle at production ($\frac{r_g}{r_\alpha^*} << 1$), where the radius of the particle is its Compton wavelength bar ($r_\alpha^* = \lambda\!\!\!^{-}_c$).

$$F = \frac{Gm_1 m_2}{r^2} \quad (26.3)$$

where $G$ is the Newtonian gravitational constant. Eq. (26.2) relativistically corrects Newton's gravitational theory. In an analogous manner, Lorentz transformations correct Newton's laws of mechanics.

The effects of gravity preclude the existence of inertial frames in a large region, and only local inertial frames, between which relationships are determined by gravity are possible. In short, the effects of gravity are only in the determination of the local inertial frames. The frames

depend on gravity, and the frames describe the spacetime background of the motion of matter. Therefore, differing from other kinds of forces, gravity which influences the motion of matter by determining the properties of spacetime is itself described by the metric of spacetime. It was demonstrated in the Gravity Section of Mills [4] that gravity arises from the two spatial dimensional mass density functions of the fundamental particles.

It is demonstrated in the One Electron Atom Section of Mills [4] that a bound electron given as a solution of the electron wavefunction with a nonradiative boundary constraint is a two-dimensional spherical shell— an orbitsphere. On the atomic scale, the curvature, $K$, is given by $\frac{1}{r_n^2}$, where $r_n$ is the radius of the radial delta function of the orbitsphere. The velocity of the electron is a constant on this two dimensional sphere. It is this local, positive curvature of the electron that causes gravity. It is worth noting that all ordinary matter, comprised of leptons and quarks, has positive curvature. Euclidean plane geometry asserts that (in a plane) the sum of the angles of a triangle equals 180°. In fact, this is the definition of a flat surface. For a triangle on an orbitsphere the sum of the angles is greater than 180°, and the orbitsphere has *positive curvature*. For some surfaces the sum of the angles of a triangle is less than 180°; these are said to have *negative curvature*.

| sum of angles of a triangle | type of surface |
|---|---|
| > 180° | positive curvature |
| = 180° | flat |
| < 180° | negative curvature |

The measure of Gaussian curvature, $K$, at a point on a two dimensional surface is

$$K = \frac{1}{r_1 r_2} \tag{26.4}$$

the inverse product of the radius of the maximum and minimum circles, $r_1$ and $r_2$, which fit the surface at the point, and the radii are normal to the surface at the point. By a theorem of Euler, these two circles lie in orthogonal planes. For a sphere, the radii of the two circles of curvature are the same at every point and equivalent to the radius of a great circle of the sphere. Thus, the sphere is a surface of constant curvature;

$$K = \frac{1}{r^2} \tag{26.5}$$

at every point. In case of positive curvature of which the sphere is an example, the circles fall on the same side of the surface, but when the circles are on opposite sides, the curve has negative curvature. A saddle, a cantenoid, and a pseudosphere are negatively curved. The general equation of a saddle is

$$z = \frac{x^2}{a^2} - \frac{y^2}{b^2} \tag{26.6}$$

where $a$ and $b$ are constants. The curvature of the surface of Eq. (26.6) is

$$K = \frac{-1}{4a^2b^2}\left[\frac{x^2}{a^4} + \frac{y^2}{b^4} + \frac{1}{4}\right]^{-2} \tag{26.7}$$

A saddle is shown schematically in FIGURE 1.

A pseudosphere is constructed by revolving the tractrix about its asymptote. For the tractrix, the length of any tangent measured from the point of tangency to the x-axis is equal to the height $R$ of the curve from its asymptote-in this case the x-axis. The pseudosphere is a surface of constant negative curvature. The curvature, $K$

$$K = \frac{-1}{r_1 r_2} = \frac{-1}{R^2} \tag{26.8}$$

given by the product of the two principal curvatures on opposite sides of the surface is equal to the inverse of $R$ squared at every point where $R$ is the equitangent. $R$ is also

known as the radius of the pseudosphere. A pseudosphere is shown schematically in FIGURE 2.

In the case of a sphere, surfaces of constant potential are concentric spherical shells. The general law of potential for surfaces of constant curvature is

$$V = \frac{1}{4\pi\varepsilon_o}\sqrt{\frac{1}{r_1 r_2}} = \frac{1}{4\pi\varepsilon_o R} \tag{26.9}$$

In the case of a pseudosphere the radii $r_1$ and $r_2$, the two principal curvatures, represent the distances measured along the normal from the negative potential surface to the two sheets of its evolute, envelop of normals (cantenoid and x-axis). The force is given as the gradient of the potential which is proportional to $\frac{1}{r^2}$ in the case of a sphere.

All matter is comprised of fundamental particles, and all fundamental particles exists as mass confined to two spatial dimensions. The particle's velocity surface is positively curved in the case of an orbitsphere, or the velocity surface is negatively curved in the case of an electron as a hyperboloid (hereafter called a hyperbolic electron given in the Hyperbolic Electrons Section). The effect of this "local" curvature on the non-local spacetime is to cause it to be Riemannian, in the case of an orbitsphere, or hyperbolic, in the case of a hyperbolic electron, as opposed to Euclidean which is manifest as a gravitational field that is attractive or repulsive, respectively. Thus, the spacetime is curved with constant spherical curvature in the case of an orbitsphere, or spacetime is curved with hyperbolic curvature in the case of a hyperbolic electron.

The relativistic correction for spacetime dilation and contraction due to the production of a particle with positive curvature is given by Eq. (23.17)

$$f(r) = \left(1 - \left(\frac{v_g}{c}\right)^2\right) \tag{26.10}$$

The derivation of the relativistic correction factor of spacetime was based on the constant maximum velocity of light and a finite positive Newtonian gravitational velocity $v_g$

of the particle given by

$$v_g = \sqrt{\frac{2Gm_0}{r}} = \sqrt{\frac{2Gm_0}{\lambda_C}} \qquad (26.11)$$

Consider a Newtonian gravitational radius, $r_g$, of each orbitsphere of the particle production event, each of mass $m$

$$r_g = \frac{2Gm}{c^2} \qquad (26.12)$$

where $G$ is the Newtonian gravitational constant. Substitution of Eq. (26.11) or Eq. (26.12) into the Schwarzschild metric Eq. (26.2), gives

$$d\tau^2 = \left(1 - \left(\frac{v_g}{c}\right)^2\right)dt^2 - \frac{1}{c^2}\left[\left(1 - \left(\frac{v_g}{c}\right)^2\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \qquad (26.13)$$

and

$$d\tau^2 = \left(1 - \frac{r_g}{r}\right)dt^2 - \frac{1}{c^2}\left[\left(1 - \frac{r_g}{r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \qquad (26.14)$$

respectively. The solutions for the Schwarzschild metric exist wherein the relativistic correction to the gravitational velocity $v_g$ and the gravitational radius $r_g$ are of the opposite sign (i.e. negative). In these cases the Schwarzschild metric Eq. (26.2), is

$$d\tau^2 = \left(1 + \left(\frac{v_g}{c}\right)^2\right)dt^2 - \frac{1}{c^2}\left[\left(1 + \left(\frac{v_g}{c}\right)^2\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \qquad (26.15)$$

and

$$d\tau^2 = \left(1 + \frac{r_g}{r}\right)dt^2 - \frac{1}{c^2}\left[\left(1 + \frac{r_g}{r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \qquad (26.16)$$

The metric given by Eqs. (26.13-26.14) corresponds to positive curvature. The metric given by Eqs. (26.15-26.16) corresponds to negative curvature. The negative solution arises naturally as a match to the boundary condition of matter with a velocity function having negative curvature. Consider the case of pair production given in the Gravity Section of Mills [4]. The photon equation given in the Equation of the Photon Section of Mills [4] is equivalent to the electron and positron functions given by in the One Electron Atom Section of Mills [4]. The velocity of any point on the positively curved electron orbitsphere is constant which

correspond to the trigonometric function given in Eqs. (1.68-1.69). At particle production, the relativistic corrections to spacetime due to the constant gravitational velocity $v_g$ are given by Eqs. (26.13-26.14). In the case of negative curvature, the electron velocity as a function of position is not constant. It may be described by a harmonic variation which corresponds to an imaginary velocity.. The trigonometric function of the positively curved electron orbitsphere given in Eqs. (1.68-1.69) becomes a hyperbolic function (e.g. cosh) in the case of a negatively curved electron. Substitution of an imaginary velocity with respect to a gravitating body into Eq. (26.13) givens Eq. (26.15). Substitution a negative radius of curvature with respect to a gravitating body into Eq. (26.14) gives Eq. (26.16). Thus, force corresponding to a negative gravitational mass can be created by forcing matter into negative curvature of the velocity surface. A fundamental particle with negative curvature of the velocity surface would experience a central but repulsive force with a gravitating body comprised of matter of positive curvature of the velocity surface.

POSITIVE, ZERO, AND NEGATIVE GRAVITATIONAL MASS

In the case of Einstein's gravity equation (Eq. (23.40)), the Einstein's Tensor $G_{\mu\nu}$, is equal to the stress-energy-momentum tensor $T_{\mu\nu}$. The only possibility is for the gravitational mass to be equivalent to the inertial mass. A particle of zero or negative gravitational mass is not possible. However, it is shown in the Gravity Section of Mills [4] that the correct basis of gravitation is not according to Einstein's equation (Eq. (23.40)); instead the origin of gravity is the relativistic correction of spacetime itself which is analogous to the special relativistic corrections of inertial parameters--increase in mass, dilation in time, and contraction in length in the direction of constant relative motion of separate inertial frames. On this basis, the observed acceleration of the cosmos is predict as given in the Cosmology Section of Mills [4].

The Schwarzschild metric gives the relationship whereby matter causes relativistic corrections to spacetime that determines the curvature of spacetime and is the origin of gravity. Matter arises during particle production from a photon. According to Newton's Law of Gravitation, the production of a particle of finite mass gives rise to a gravitational velocity of the particle. The gravitational velocity determines the energy and the corresponding eccentricity and trajectory of the gravitational orbit of the particle. The eccentricity $e$ given by Newton's differential equations of motion in the case of the central field (Eq. (23.49-23.50)) permits the classification of the orbits according to the total energy $E$ as follows [7]:

$$
\begin{array}{lll}
E<0, & e<1 & \text{ellipse} \\
E<0, & e=0 & \text{circle (special case of ellipse)} \\
E=0, & e=1 & \text{parabolic orbit} \\
E>0, & e>1 & \text{hyperbolic orbit}
\end{array}
\qquad (26.17)
$$

Since $E=T+V$ and is constant, the closed orbits are those for which $T<|V|$, and the open orbits are those for which $T\geq|V|$. It can be shown that the time average of the kinetic energy, $<T>$, for elliptic motion in an inverse square field is $1/2$ that of the time average of the potential energy, $<V>$. $<T>=1/2<V>$.

In the case that a particle of inertial mass $m$ is observed to have a speed $v_0$, a distance from a massive object $r_0$, and a direction of motion makes that an angle $\phi$ with the radius vector from the object (including a particle) of mass $M$, the total energy is given by

$$E=\frac{1}{2}mv^2-\frac{GMm}{r}=\frac{1}{2}mv_0^2-\frac{GMm}{r_0}=\text{constant} \qquad (26.18)$$

The orbit will be elliptic, parabolic, or hyperbolic, according to

whether $E$ is negative, zero, or positive. Accordingly, if $v_0^2$ is less than, equal to, or greater than $\frac{2GM}{r_0}$, the orbit will be an ellipse, a parabola, or a hyperbola, respectively. Since $h$, the angular momentum per unit mass, is

$$h = L/m = |\mathbf{r} \times \mathbf{v}| = r_0 v_0 \sin\phi \qquad (26.19)$$

The eccentricity $e$, from Eq. (23.63) may be written as

$$e = [1 + \left(v_0^2 - \frac{2GM}{r_0}\right)\frac{r_0^2 v_0^2 \sin^2\phi}{G^2 M^2}]^{1/2} \qquad (26.20)$$

As shown in the Gravity Section of Mills [4] (Eq. (23.35)), the production of a particle requires that the velocity of each of the point masses of the particle is equivalent to the Newtonian gravitational escape velocity $v_g$ of the superposition of the point masses of the antiparticle.

$$v_g = \sqrt{\frac{2Gm}{r}} = \sqrt{\frac{2Gm_0}{\lambda_C}} \qquad (26.21)$$

From Eq. (26.20) and Eq. (26.17), the eccentricity is one and the particle production trajectory is a parabola relative to the center of mass of the antiparticle. The right-hand side of Eq. (23.43) represents the correction to the laboratory coordinate metric for time corresponding to the relativistic correction of spacetime by the particle production event. Riemannian space is conservative. Only changes in the metric of spacetime during particle production must be considered. The changes must be conservative. For example, pair production occurs in the presence of a heavy body. A nucleus which existed before the production event only serves to conserve momentum but is not a factor in determining the change in the properties of spacetime as a consequence of the pair production event. The effect of this and other external gravitating bodies are equal on the photon and resulting particle and antiparticle and do not effect the boundary conditions for particle production. For particle production to occur, the particle must possess the escape velocity relative to the antiparticle where Eqs. (23.34), (23.48), and (23.140) apply. In other cases not involving particle production such as a special electron scattering event wherein hyperbolic

electron production occurs as given *infra*, the presence of an external gravitating body must be considered. The curvature of spacetime due to the presence of a gravitating body and the constant maximum velocity of the speed of light comprise boundary conditions for hyperbolic electron production from a free electron.

With particle production, the form of the outgoing gravitational field front traveling at the speed of light (Eq. (23.10)) is

$$f\left(t-\frac{r}{c}\right) \tag{26.22}$$

At production, the particle must have a finite velocity called the gravitational velocity according to Newton's Law of Gravitation. In order that the velocity does not exceed $c$ in any frame including that of the particle having a finite gravitational velocity, the laboratory frame of an incident photon that gives rise to the particle, and that of a gravitational field propagating outward at the speed of light, spacetime must undergo time dilation and length contraction due to the production event. During particle production the speed of light as a constant maximum as well as phase matching and continuity conditions require the following form of the squared displacements due to constant motion along two orthogonal axes in polar coordinates:

$$(c\tau)^2+(v_g t)^2=(ct)^2 \tag{26.23}$$

$$(c\tau)^2=(ct)^2-(v_g t)^2 \tag{26.24}$$

$$\tau^2=t^2\left(1-\left(\frac{v_g}{c}\right)^2\right) \tag{26.25}$$

Thus,

$$f(r)=\left(1-\left(\frac{v_g}{c}\right)^2\right) \tag{26.26}$$

(The derivation and result of spacetime time dilation is analogous to the derivation and result of special relativistic time dilation given by Eqs. (22.11-22.15).) Consider a gravitational radius, $r_g$, of each orbitsphere of the particle production event, each of mass $m$

$$r_g = \frac{2Gm}{c^2} \qquad (26.27)$$

where $G$ is the Newtonian gravitational constant. Substitution of Eq. (26.11) or Eq. (26.12) into the Schwarzschild metric Eq. (26.2), gives the general form of the metric due to the relativistic effect on spacetime due to mass $m_0$.

$$d\tau^2 = \left(1 - \left(\frac{v_g}{c}\right)^2\right)dt^2 - \frac{1}{c^2}\left[\left(1 - \left(\frac{v_g}{c}\right)^2\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \qquad (26.28)$$

and

$$d\tau^2 = \left(1 - \frac{r_g}{r}\right)dt^2 - \frac{1}{c^2}\left[\left(1 - \frac{r_g}{r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \qquad (26.29)$$

respectively. Masses and their effects on spacetime superimpose; thus, the metric corresponding to the Earth is given by substitution of the mass of the Earth $M$ for $m$ in Eqs. (26.13-26.14). The corresponding Schwarzschild metric Eq. (26.2) is

$$d\tau^2 = \left(1 - \frac{2GM}{c^2 r}\right)dt^2 - \frac{1}{c^2}\left[\left(1 - \frac{2GM}{c^2 r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \qquad (26.30)$$

Gravitational and electromagnetic forces are both inverse squared central forces. The inertial mass corresponds to the inertial angular momentum and the gravitational mass corresponds to the gravitational angular momentum. In the case that an electron is bound in by electromagnetic forces in a nonradiative orbit, the following condition from the particle production relationships given by Eq. (24.41) hold

$$\frac{\text{proper time}}{\text{coordinate time}} = \frac{\text{gravitational wave condition}}{\text{electromagnetic wave condition}} = \frac{\text{gravitational mass phase matching}}{\text{charge/inertial mass phase matching}}$$

$$\frac{\text{proper time}}{\text{coordinate time}} = i\frac{\sqrt{\frac{2Gm}{c^2\lambda_C}}}{\alpha} = i\frac{v_g}{\alpha c} \qquad (26.31)$$

The gravitational and inertial angular momentum correspond to the same mass; thus, the inertial and gravitational masses

are identically equal for all matter in a stable bound state.

Consider the case that the radius in Eq. (26.30) goes to infinity. From Eq. (26.20) and Eq. (26.17) in the case that $r_0$ goes to infinity, the eccentricity is always greater than or equal to one and approaches infinity, and the trajectory is a parabola or a hyperbola. The gravitational velocity (Eq. (26.21)) where $m = M$ goes to zero. This condition must hold from all $r_0$; thus, the free electron is not effected by the gravitational field of a massive object, but has inertial mass determined by the conservation of the angular momentum of $\hbar$ as shown by Eqs. (3.14-3.15). From the Electron in Free Space Section of Mills [4], the free electron has a velocity distribution given by

$$\mathbf{v}(\rho,\phi,z,t) = \left[\pi\left(\frac{\rho}{2\rho_o}\right)\frac{\hbar}{m_e\sqrt{{\rho_0}^2-\rho^2}}\,\mathbf{i}_\phi\right]$$

$$\mathbf{v}(\rho,\phi,z,t) = \left[\pi\left(\frac{\rho}{2\rho_o}\right)\frac{\hbar}{m_e\rho_o\sqrt{1-\left(\frac{\rho}{\rho_o}\right)^2}}\,\mathbf{i}_\phi\right] \tag{26.32}$$

The velocity function is a paraboloid in a two dimensional plane. The corresponding gravity field front corresponds to a radius at infinity in Eq. (26.22). As a consequence, an ionized or free electron has a gravitational mass that is zero; whereas, the inertial mass is constant (e.g. equivalent to its mass energy given by Eq. (24.13)). Minkowski space applies to the free electron.

In the Electron in Free Space Section of Mills [4], a free electron is shown to be a two-dimensional plane wave—a flat surface. Because the gravitational mass depends on the positive curvature of a particle, a free electron has inertial mass but not gravitational mass. The experimental mass of the free electron measured by Witteborn [8] using a free fall technique is less than $0.09\,m_e$, where $m_e$ is the inertial mass of the free electron $(9.109534\,X\,10^{-31}\,kg)$. Thus, a free electron is not gravitationally attracted to ordinary matter, and the

gravitational and inertial masses are not equivalent. Furthermore, it is possible to give the electron velocity function negative curvature and, therefore, cause it to have opposite behavior in a gravitational field.

As is the case of special relativity, the velocity of a particle in the presence of a gravitating body is relative. In the case that the relative gravitational velocity is imaginary, the eccentricity is always greater than one, and the trajectory is a hyperbola. This case corresponds to a hyperbolic electron wherein gravitational mass is effectively negative and the inertial mass is constant (e.g. equivalent to its mass energy given by Eq. (24.13)). The formation of a hyperbolic electron occurs over the time that the plane wave free electron scatters from the neutral atom. Huygens' principle, Newton's law of Gravitation, and the constant speed of light in all inertial frames provide the boundary conditions to determine the metric corresponding to the hyperbolic electron. From Eq. (26.71), the velocity $\mathrm{v}(\rho,\phi,z,t)$ on a two dimensional sphere in spherical coordinates is

$$\mathrm{v}(r,\theta,\phi,t)=\left[\frac{\hbar}{m_e r_0 \sin\theta}\delta(r-r_0)\,\mathbf{i}_\phi\right] \tag{26.33}$$

With hyperbolic electron production, the form of the outgoing gravitational field front traveling at the speed of light (Eq. (23.10)) is

$$f\left(t-\frac{r}{c}\right) \tag{26.34}$$

During hyperbolic electron production the speed of light as a constant maximum as well as phase matching and continuity conditions require the following form of the squared displacements due to constant motion along two orthogonal axes in polar coordinates:

$$(c\tau)^2+\left(v_g t\right)^2=(ct)^2 \tag{26.35}$$

According to Eq. (3.11), the velocity of the electron on the two dimension sphere approaches the speed of light at the angular extremes ($\theta=0$ and $\theta=\pi$), and the velocity is harmonic as a function of theta. The speed of any signal can not exceed the speed of light. Therefore, the outgoing two

dimensional spherical gravitational field front traveling at the speed of light and the velocity of the electron at the angular extremes require that the relative gravitational velocity must be radially outward. The relative gravitational velocity squared of the term $(v_g t)^2$ of Eq. (26.35) must be negative. In this case, the relative gravitational velocity may be considered imaginary which is consistent with the velocity as a harmonic function of theta. The energy of the orbit of the hyperbolic electron must always be greater than zero which corresponds to a hyperbolic trajectory and an eccentricity greater than one (Eq. (26.17) and Eq. (26.20)). From Eq. (26.20) and Eq. (26.21) with the requirements that the relative gravitational velocity must be imaginary and the energy of the orbit must always be positive, the relative gravitational velocity for a hyperbolic electron produced in the presence of the gravitational field of the Earth is

$$v_g = i\sqrt{\frac{2GM}{r}} \qquad (26.36)$$

where $M$ is the mass of the Earth. Substitution of Eq. (26.36) into Eq. (26.35) gives

$$(c\tau)^2 = (ct)^2 + (v_g t)^2 \qquad (26.37)$$

$$\tau^2 = t^2\left(1 + \left(\frac{v_g}{c}\right)^2\right) \qquad (26.38)$$

Thus,

$$f(r) = \left(1 + \left(\frac{v_g}{c}\right)^2\right) \qquad (26.39)$$

Consider a gravitational radius, $r_g$, of a massive object of mass $M$ relative to a hyperbolic electron at the production event that is negative to match the boundary condition of a negatively curved velocity surface

$$r_g = -\frac{2GM}{c^2} \qquad (26.40)$$

where $G$ is the Newtonian gravitational constant. Substitution of Eq. (26.36) or Eq. (26.40) into the Schwarzschild metric Eq. (26.2), gives the general form of the metric due to the relativistic effect on spacetime due to a

massive object of mass $M$ relative to the hyperbolic electron.

$$d\tau^2 = \left(1+\left(\frac{v_g}{c}\right)^2\right)dt^2 - \frac{1}{c^2}\left[\left(1+\left(\frac{v_g}{c}\right)^2\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \quad (26.41)$$

and

$$d\tau^2 = \left(1+\frac{r_g}{r}\right)dt^2 - \frac{1}{c^2}\left[\left(1+\frac{r_g}{r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta d\phi^2\right] \quad (26.42)$$

respectively.

PROPULSION DEVICE

It is possible to give the velocity function of electrons negative curvature by elastically scattering electrons of an electron beam from atoms such that electrons with negatively curved velocity surfaces (hyperbolic electrons) emerge. The emerging beam of electrons with negatively curved velocity surfaces experience a repulsive gravitational force (on the Earth), and the beam will tend to move upward (away from the Earth). To use this invention for propulsion, the repulsive gravitational force of the electron beam must be transferred to a negatively charged plate. The Coulombic repulsion between the beam of electrons and the negatively charged plate will cause the plate (and anything connected to the plate) to lift. FIGURE 3 gives a schematic of a propulsion device according to the present invention.

(a) a beam of electrons is generated at electron source 210 and directed to the neutral atomic beam 214 formed by neutral atomic beam source 211

(b) scattering of the electrons of the electron beam 213 by the neutral atom beam 214 gives the electrons negative curvature of their velocity surfaces, and the hyperbolic electrons 215 experience a force upward (away from the earth)

(c) the electrons 215, which would normally bend down toward the positive plate 218 but do not

because of the repulsive gravitational force, repel the negative plate 217 and attract the positive plate 218, and transfer the force to the object to be lifted or propelled due to a structural connection 220 between the plates 217 and 218 and the object.

(d) the electrons 215 are collected by electron dump 216 or recirculated back to the electron beam by recirculator 216

(e) the neutral atomic beam 214 is recirculated by neutral atom recirculator 212

HYPERBOLIC ELECTRONS

A method and means to produce an repulsive gravitational force for propulsion comprises a source of fundamental particles including electrons and a source of neutral atoms. The source of electrons produces a free electron beam, and the source of neutral atoms produces a free atom beam. The two beams intersect such that the neutral atoms cause elastic incompressible scattering of the electrons of the electron beam to form hyperbolic electrons. In a preferred embodiment, the de Broglie wavelength of each electron is given by

$$\lambda_o = \frac{h}{m_e v_z} = 2\pi\rho_o \tag{26.43}$$

where $\rho_o$ is the radius of the free electron in the xy-plane, the plane perpendicular to its direction of propagation. The velocity of each electron follows from Eq. (26.43)

$$v_z = \frac{h}{m_e\lambda_o} = \frac{h}{m_e 2\pi\rho_o} = \frac{\hbar}{m_e\rho_o} \tag{26.44}$$

The elastic electron scattering in the far field is given by the Fourier Transform of the aperture function as described in Electron Scattering by Helium Section of Mills [4]. The convolution of a uniform plane wave with on orbitsphere of radius $z_o$ is given by Eq. (8.43) and Eq. (8.44).

The aperture distribution function, $a(\rho,\phi,z)$, for the scattering of an incident plane wave by the He atom is given by the convolution of the plane wave function with the two electron orbitsphere Dirac delta function of $radius = 0.567a_o$ and charge/mass density of $\frac{2}{4\pi(0.567a_o)^2}$. For radial units in terms of $a_o$

$$a(\rho,\phi,z) = \pi(z) \otimes \frac{2}{4\pi(0.567a_o)^2}[\delta(r-0.567a_o)] \qquad (26.45)$$

where $a(\rho,\phi,z)$ is given in cylindrical coordinates, $\pi(z)$, the xy-plane wave is given in Cartesian coordinates with the propagation direction along the z-axis, and the He atom orbitsphere function, $\frac{2}{4\pi(0.567a_o)^2}[\delta(r-0.567a_o)]$, is given in spherical coordinates.

$$a(\rho,\phi,z) = \frac{2}{4\pi(0.567a_o)^2}\sqrt{(0.567a_o)^2 - z^2}\,\delta(r - \sqrt{(0.567a_o)^2 - z^2}) \qquad (26.46)$$

The convolution of the charge-density equation of a free electron given by Eq. (3.7) with an orbitsphere of radius $z_o$ follows from Eq. (3.7) and Eq. (26.46)

$$\rho_m(\rho,\phi,z) = \sqrt{\rho_0^2-\rho^2}\sqrt{z_0^2-z^2}\,\delta\left(\rho-\sqrt{z_0^2-z^2}\right) \qquad (26.47)$$

Substitution of Eq. (26.47) into Eq. (8.45) gives

$$F(s) = \frac{1}{z_o^2}\int_{-z_o}^{z_o}\sqrt{\rho_o^2-(z_o^2-z^2)}(z_o^2-z^2)J_o\left(s\sqrt{z_o^2-z^2}\right)e^{iwz}dz \qquad (26.48)$$

Substitution $\frac{z}{z_o} = -\cos\theta$ into Eq. (26.48) gives

$$F(s) = \int_0^{\pi}\sqrt{\rho_o^2 - z_o^2\sin^2\theta}\,\sin^3\theta J_o(sz_o\sin\theta)e^{iz_o w\cos\theta}d\theta \qquad (26.49)$$

when $\rho_o = z_o$, Eq. (26.49) becomes

$$F(s) = z_o\int_0^{\pi}\cos\theta\sin^3\theta J_o(sz_o\sin\theta)e^{iz_o w\cos\theta}d\theta \qquad (26.50)$$

The function of the scattered electron in the far field is given by the Fourier Transform integral, Eq. (26.50). Eq. (26.50) is equivalent to the Fourier Transform integral of $\cos\theta$ times the Fourier Transform integral given by of Eq. (8.47) with the latter result given by Eq. (8.50).

$$F(s)=\left[\frac{2\pi}{(z_o w)^2+(z_o s)^2}\right]^{\frac{1}{2}}$$

$$\left\{2\left[\frac{z_o s}{(z_o w)^2+(z_o s)^2}\right]J_{3/2}\left[((z_o w)^2+(z_o s)^2)^{1/2}\right]-\left[\frac{z_o s}{(z_o w)^2+(z_o s)^2}\right]^2 J_{5/2}\left[((z_o w)^2+(z_o s)^2)^{1/2}\right]\right\}$$

(26.51)

where

$$s=\frac{4\pi}{\lambda}\sin\frac{\theta}{2};\ w=0\ (units\ of\ \mathring{A}^{-1}) \qquad (26.52)$$

A very important theorem of Fourier analysis states that the Fourier Transform of a product is the convolution of the individual Fourier Transforms. The Fourier Transform of $\cos\theta$ is

$$\frac{[\delta(\Theta-\Theta_o)+\delta(\Theta+\Theta_o)]}{2} \qquad (26.53)$$

The Fourier Transform integral, Eq. (26.50), is the convolution of Eqs. (26.51-26.52) and Eq. (26.53). The convolution gives the result that Eq. (26.52) is given by

$$s=\frac{4\pi}{\lambda}\sin\left(\frac{\theta-\Theta_o}{2}\right);\ w=0\ (units\ of\ ^{-1}) \qquad (26.54)$$

Given that $z=z_o\cos\theta$, the mass density function of each electron having a de Broglie wavelength $\lambda_o$ given by Eq. (26.43) corresponding to $\lambda$ in Eq. (26.54) which is elastically scattered by an atom having a radius of $z_o=\rho_o$ is given by Eqs. (26.51) and (26.54). The replacement of $\pi(z)$, the xy-plane wave corresponding to the superposition of many electrons scattered from an atomic beam with the function of a single electron propagating in the z-direction (Eq. (3.7)) gives rise to the electron density function on a two dimensional sphere of

$$\rho_m(\rho,\phi,z)=Nm_e\sqrt{\rho_0^{\,2}-z^2}\,\delta\left(\rho-\sqrt{\rho_0^{\,2}-z^2}\right) \qquad (26.55)$$

centered at a scattering angle of $\Theta_o$. With the condition $z_o=\rho_o$, the elastic electron scattering angle in the far field $\Theta_o$ is determined by the boundary conditions of the curvature of spacetime due to the presence of a gravitating body and the

constant maximum velocity of the speed of light. The far field condition must be satisfied with respect to electron scattering and the gravitational orbital equation. The former condition is met by Eq. (26.51) and Eq. (26.54). The latter is derived in the Preferred Embodiment of a Propulsion Device Section and is met by Eq. (26.103) where the far field angle of the hyperbolic gravitational trajectory $\phi$ is equivalent to $\Theta_o$.

The electron mass/charge density function, $\rho_m(\rho,\phi,z)$, is given in cylindrical coordinates, and $N$ is the normalization factor. The charge density, mass density, velocity, current density, and angular momentum functions are derived in the same manner as for the free electron given in the Electron in Free Space Section of Mills [4] except that the scattered electron is symmetric about the z-axis. The total mass is $m_e$. Thus, Eq. (26.55) must be normalized.

$$m_e = N\int_{-\rho_0}^{\rho_0}\int_{0}^{2\pi}\int_{-\infty}^{\infty}\sqrt{\rho_0^2 - z^2}\,\delta\left(\rho - \sqrt{\rho_0^2 - z^2}\right)\rho d\rho d\phi dz \tag{26.56}$$

$$N = \frac{m_e}{\frac{8}{3}\pi\rho_0^3} \tag{26.57}$$

The mass density function, $\rho_m(\rho,\phi,z)$, of the scattered electron is

$$\rho_m(\rho,\phi,z) = \frac{m_e}{\frac{8}{3}\pi\rho_0^3}\sqrt{\rho_0^2 - z^2}\,\delta\left(\rho - \sqrt{\rho_0^2 - z^2}\right)$$
$$\rho_m(\rho,\phi,z) = \frac{m_e}{\frac{8}{3}\pi\rho_0^3}\rho_0\sqrt{1-\left(\frac{z}{\rho_0}\right)^2}\,\delta\left(\rho - \rho_0\sqrt{1-\left(\frac{z}{\rho_0}\right)^2}\right) \tag{26.58}$$

and charge-density distribution, $\rho_e(\rho,\phi,z)$, is

$$\rho_e(\rho,\phi,z) = \frac{e}{\frac{8}{3}\pi\rho_0^3}\sqrt{\rho_0^2 - z^2}\,\delta\left(\rho - \sqrt{\rho_0^2 - z^2}\right)$$
$$\rho_e(\rho,\phi,z) = \frac{e}{\frac{8}{3}\pi\rho_0^3}\rho_0\sqrt{1-\left(\frac{z}{\rho_0}\right)^2}\,\delta\left(\rho - \rho_0\sqrt{1-\left(\frac{z}{\rho_0}\right)^2}\right) \tag{26.59}$$

The magnitude of the angular velocity of the helium orbitsphere is given by Eq. (1.55) is

$$\omega = \frac{\hbar}{m_e r^2} \tag{26.60}$$

where $r = r_0 = \rho_0 = z_0 = 0.567a_0$ and $a_0$ is the Bohr radius. The current-density function of the scattered electron, $\mathbf{K}(\rho,\phi,z,t)$, is the projection along the z-axis of the integral of the product of the projections of the charge of the orbitsphere (Eq. (3.3)) times the angular velocity as a function of the radius $r$ of an ionizing orbitsphere (Eq. (3.9)) for $r = r_o$ to $r = \infty$. The integral is

$$\int_{r_o}^{\infty} \omega \pi(z) \otimes \delta(r - r_o)dr = \frac{e}{\frac{8}{3}\pi r_0^3} \int_{r_o}^{\infty} \frac{\hbar}{m_e r^2} \sqrt{r_0^2 - z^2}\,\delta(r - \sqrt{r_0^2 - z^2})dr \tag{26.61}$$

The projection of Eq. (26.61) along the z-axis is

$$\mathbf{J}(\rho,\phi,z,t) = \left[ \frac{e}{\frac{8}{3}\pi\rho_0^3} \frac{\hbar}{m_e\sqrt{\rho_0^2 - z^2}} \delta\left(\rho - \sqrt{\rho_0^2 - z^2}\right) \mathbf{i}_\phi \right] \tag{26.62}$$

The velocity $\mathbf{v}(\rho,\phi,z,t)$ along the z-axis is

$$\mathbf{v}(\rho,\phi,z,t) = \left[ \frac{\hbar}{m_e\sqrt{\rho_0^2 - z^2}} \delta\left(\rho - \sqrt{\rho_0^2 - z^2}\right) \mathbf{i}_\phi \right]$$

$$\mathbf{v}(\rho,\phi,z,t) = \left[ \frac{\hbar}{m_e\rho_0\sqrt{1 - \left(\frac{z}{\rho_0}\right)^2}} \delta\left(\rho - \rho_0\sqrt{1 - \left(\frac{z}{\rho_0}\right)^2}\right) \mathbf{i}_\phi \right] \tag{26.63}$$

where $\rho_o = r_o$. The angular momentum, $\mathbf{L}$, is given by

$$\mathbf{L}\mathbf{i}_z = m_e r^2 \omega = \mathbf{L} = mr^2\mathbf{w} = m\mathbf{r} \times \mathbf{v} \tag{26.64}$$

Substitution of $m_e$ for $e$ in Eq. (26.62) followed by substitution into Eq. (26.64) gives the angular momentum density function, $\mathbf{L}$

$$\mathbf{L}\mathbf{i}_z = \frac{m_e}{\frac{8}{3}\pi\rho_0^3} \frac{\hbar}{m_e\sqrt{\rho_0^2 - z^2}} \rho^2 \delta\left(\rho - \sqrt{\rho_0^2 - z^2}\right) \tag{26.65}$$

The total angular momentum of the scattered electron is given by integration over the two dimensional negatively curved surface having the angular momentum density given by Eq. (26.65).

$$\mathbf{Li}_z = \int_{-\rho_0}^{\rho_0}\int_0^{2\pi}\int_{-\infty}^{\infty} \frac{m_e}{\frac{8}{3}\pi\rho_0^{\,3}} \frac{\hbar}{m_e\sqrt{\rho_0^{\,2}-z^2}} \delta\left(\rho-\sqrt{\rho_0^2-z^2}\right)\rho^2 \rho d\rho d\phi dz \tag{26.66}$$

$$\mathbf{Li}_z = \hbar \tag{26.67}$$

Eq. (26.67) is in agreement with Eq. (1.130); thus, the scalar sum of the magnitude of the angular momentum is conserved.

The mass, charge, and current of the scattered electron exist on a two dimension sphere which may be given in spherical coordinates where theta is with respect to the z-axis of the original cylindrical coordinate system. The mass density function, $\rho_m(r,\theta,\phi)$, of the scattered electron in spherical coordinates is

$$\rho_m(r,\theta,\phi) = \frac{m_e}{\frac{8}{3}\pi r_0^{\,3}} r_0 \sin^2\theta\delta(r-r_0) \tag{26.68}$$

The charge-density distribution, $\rho_e(r,\theta,\phi)$, in spherical coordinates is

$$\rho_e(r,\theta,\phi) = \frac{e}{\frac{8}{3}\pi r_0^{\,3}} r_0 \sin^2\theta\delta(r-r_0) \tag{26.69}$$

The current density function $\mathbf{J}(r,\theta,\phi,t)$, in spherical coordinates is

$$\mathbf{J}(r,\theta,\phi,t) = \left[\frac{e}{\frac{8}{3}\pi r_0^{\,2}} \frac{\hbar}{m_e r_0^2} \sin\theta\delta(r-r_0)\,\mathbf{i}_\phi\right] \tag{26.70}$$

The velocity $\mathbf{v}(\rho,\phi,z,t)$ in spherical coordinates is

$$\mathbf{v}(r,\theta,\phi,t) = \left[\frac{\hbar}{m_e r_0 \sin\theta}\delta(r-r_0)\,\mathbf{i}_\phi\right] \tag{26.71}$$

The total angular momentum of the scattered electron is given by integration over the two dimensional negatively curved surface having the angular momentum density in spherical coordinates given by

$$\mathbf{Li}_z = \int_0^{2\pi}\int_0^{\pi}\int_0^{\infty} \frac{m_e}{\frac{8}{3}\pi r_0^{\,3}} \frac{\hbar}{m_e r_0} r^2 \sin^2\theta\delta(r-r_0) r^2 \sin\theta dr d\theta d\phi \tag{26.72}$$

$$\mathbf{Li}_z = \hbar \tag{26.73}$$

where $\rho_o = r_o$.

The electron orbitsphere of an atom has a constant velocity as a function of angle. Whereas, the electron orbitsphere formed when the radius of the incoming electron is equal to the radius of the scattering atom (i.e. $z_o = \rho_o$) has a velocity function whose magnitude is harmonic in theta (Eq. (26.71)). The velocity function (Eq. (26.63) or Eq. (26.71)) is a hyperboloid. It exists on a two dimension sphere; thus, it is spatially bounded. The mass and charge functions given by Eq. (26.68) and Eq. (26.69), respectively, are finite on a two dimensional sphere; thus, they are bounded. The scattered electron having a negatively curved two dimensional velocity surface is called a hyperbolic electron. The magnetic field of the current-density function of the hyperbolic electron provides the force balance of the centrifugal force of the mass density function as was the case for the free electron given in the Electron in Free Space Section of Mills [4]. The current density function is also nonradiative as given in that section. Hyperbolic electrons can be focused into a beam by electric and/or magnetic fields to form a hyperbolic electron beam. The velocity distribution along the z-axis of a hyperbolic electron is shown schematically in FIGURE 4. A cutaway of the velocity distribution of a hyperbolic electron is shown schematically in FIGURE 5.

The velocity is harmonic or imaginary as a function of theta. Therefore, the gravitational velocity of the Earth relative to that of the hyperbolic electron is imaginary.. This case corresponds to an eccentricity greater than one and a hyperbolic orbit of Newton's Law of Gravitation. The metric for the imaginary gravitational velocity is derived based on the center of mass of the scattering event. The Earth, helium, and the hyperbolic electron are spherically symmetrical; thus, the Schwarzschild metric (Eqs. (26-41-26.42)) applies. The velocity distribution defines a surface of negative curvature relative to the positive curvature of the Earth. This case corresponds to a negative radius of Eq. (26.40) or an imaginary gravitational velocity of Eq. (26.36). The lift due to the resulting repulsive gravitational force is given in the

Preferred Embodiment of an Propulsion Device Section. According to Eq. (23.48) and Eq. (23.140), matter, energy, and spacetime are conserved with respect to creation of a particle which is repelled from a gravitating body. The gravitationally ejected particle gains energy as it is repelled. The ejection of a particle having a negatively curved velocity surface such as a hyperbolic electron from a gravitating body such as the Earth must result in an infinitesimal decrease in its radius of the gravitating body (e.g. $r$ of the Schwarzschild metric given by Eq. (26.2) where $m_0 = M$ is the mass of the Earth). The amount that the gravitational potential energy of the gravitating body is lowered is equivalent to the energy gained by the repelled particle. The physics is time reversible. The process may be run backwards to achieve the original state before the repelled particle such as a hyperbolic electron was created.

In a preferred embodiment, the neutral atoms of the neutral atom beam comprise helium, and the velocity of the free electrons of the electron beam is

$$v_z = \frac{\hbar}{m_e \rho_o} = 3.858361 \, X \, 10^6 \; m/s \tag{26.74}$$

where $\rho_o = 0.567 a_o = 3.000434 \, X \, 10^{-11} \; m$.

In another preferred embodiment, each atom of the neutral atomic beam comprises hydrino atom $H(1/p)$, $\rho_o = \frac{a_H}{p}$; $p$ is an integer). The velocity of each electron of the free electron beam is

$$v_z = \frac{\hbar}{m_e \rho_o} = 2.187691 \, X \, 10^6 \; m/s \tag{26.75}$$

where $\rho_o = \frac{a_H}{n} = \frac{5.29177 \, X \, 10^{-11}}{n} \; m$

For a nonrelativistic electron of velocity $v_z$, the kinetic energy, $T$, is

$$T = \frac{1}{2} m_e v_z^2 \tag{26.76}$$

In the case of helium with the substitution of Eq. (26.74) into Eq. (26.76),

$$T = 42.3 \; eV \tag{26.77}$$

In the case of hydrogen with the substitution of Eq. (26.75) into Eq. (26.76),

$$T = p^2 13.6\ eV \tag{26.78}$$

PREFERRED EMBODIMENT OF A PROPULSION DEVICE

As shown schematically in FIGURE 6, the device 1 to provide a repulsive gravitational force for propulsion comprises a source 12 of a gas jet of atoms 9 such as helium atoms such as described by Bonham [9] and an energy tunable electron beam source 2 which supplies an electron beam 8 having electrons of a precise energy such that the radius of each electron is equal to the radius of each atom of the gas jet 9. Such a source is described by Bonham [9]. The gas jet 9 and electron beam 8 intersect such that the velocity function of each electron is elastically scattered and warped into a hyperboloid of negative curvature (hyperbolic electron). The hyperbolic electron beam 10 passes into an electric field provided by a capacitor means 3. In a preferred embodiment, the capacitor means 3 is along to the electron beam 8, and the intersection of the gas jet 9 and the electron beam 8 occurs inside of the capacitor means 3. The hyperbolic electrons experience a repulsive gravitational force due to their velocity surfaces of negative curvature and are accelerated away from the center of the gravitating body such as the Earth. This upward force is transferred to the capacitor means 3 via a repulsive electric force between the hyperbolic electrons and the electric field of the capacitor means 3. The capacitor means 3 is rigidly attached to the body to be levitated or propelled by structural attachment 4. The present propulsion means further includes a means to trap unscattered and hyperbolic electrons and recirculate them through the beam 8. Such a trap means 5 includes a Faraday cage as described by Bonham [9]. The present propulsion means 1 further includes a means 6 to trap and recirculate the atoms of the gas jet 9. Such a gas trap means 6 includes a pump such as a diffusion pump as described by Bonham [9] and a baffle 11.

In another embodiment according to the present invention, the apparatus for providing the repulsive gravitational force comprises a means to inject electrons and a guide means to guide the electrons. Acceleration and forming electrons having a velocity surface that is negatively curved is effected in the propagating guided electrons by application of one or more of an electric field, a magnetic field, or an electromagnetic field by a field source means. A repulsive force of interaction is created between the propagating electrons having a velocity surface that is negatively curved and the gravitational field of a gravitating body. A field source means provides an opposite force to the repulsive force. Thus, the repulsive gravitational force is transferred to the field source and the guide which further transfers the force to the attached structure to be propelled.

In the embodiment, the propulsion means shown schematically in FIGURE 7 comprises an electron beam source 100, and an electron accelerator module 101, such as an electron gun, an electron storage ring, a radiofrequency linac, an introduction linac, an electrostatic accelerator, or a microtron. The beam is focused by focusing means 112, such as a magnetic or electrostatic lens, a solenoid, a quadrapole magnet, or a laser beam. The electron beam 113, is directed into a channel of electron guide 109, by beam directing means 102 and 103, such as dipole magnets. Channel 109, comprises a field generating means to produce a constant electric or magnetic force in the direction opposite to direction of the repulsive gravitational force. For example, given that the repulsive gravitational force is negative z directed as shown in FIGURE 7, the field generating means 109, provides a constant z directed electric force due to a constant electric field in the negative z direction via a linear potential provided by grid electrodes 108 and 128. Or, given that the repulsive gravitational force is positive y directed as shown in FIGURE 7, the field generating means 109, provides a constant negative y directed electric force due to a constant electric field in the negative y direction via a linear potential

provided by the top electrode 120, and bottom electrode 121, of field generating means 109. The force provides work against the gravitational field of the gravitating body as the fundamental particle including an electron propagates along the channel of the guide means and field producing means 109. The resulting work is transferred to the means to be propelled via its attachment to field producing means 109.

The electric or magnetic force is variable until force balance with the repulsive gravitational force may be achieved. In the absence of force balance, the electrons will be accelerated and the emittance of the beam will increase. Also, the accelerated electrons will radiate; thus, the drop in emittance and/or the absence of radiation is the signal that force balance is achieved. The emittance and/or radiation is detected by sensor means 130, such as a photomultiplier tube, and the signal is used in a feedback mode by analyzer-controller 140 which varies the constant electric or magnetic force by controlling the potential or dipole magnets of (field producing) means 109 to control force balance to maximize the propulsion.

In one embodiment, the field generating means 109, further provides an electric or magnetic field that produces electrons of the electron beam 113 having a velocity surface that is negatively curved. In another embodiment, electrons of the electron beam 113 having a velocity surface are produced by the absorption of photons provided by a photon source 105, such as a high intensity photon source, such as a laser. The laser radiation can be confined to a resonator cavity by mirrors 106 and 107.

In a further embodiment, electrons from the electron beam 113 having a velocity surface that is negatively curved are produced by scattering with photons from the photon source 105. The laser radiation or the resonator cavity is oriented relative to the propagation direction of the electrons such that the scattering cross section of the electron with the photon to yield electrons having a velocity surface that is negatively curved is maximized.

Following the propagation through the field generating means 109 in which propulsion work is extracted from the beam 113, the beam 113, is directed by beam directing apparatus 104, such as a dipole magnet into electron-beam dump 110.

In a further embodiment, the beam dump 110 is replaced by a means to recover the remaining energy of the beam 113 such as a means to recirculate the beam or recover its energy by electrostatic deceleration or deceleration in a radio frequency-excited linear accelerator structure. These means are described by Feldman [10] which is incorporated by reference.

The present invention comprises high current and high energy beams and related systems of free electron lasers. Such systems are described in Nuclear Instruments and Methods in Physics Research [11-12] which are incorporated herein by reference.

TRAJECTORY

In the case of a hyperbolic electron which is much smaller then the size of a capacitor, the electric force of the hyperbolic electron on the capacitor is equivalent to that of a point charge. This force provides lift to the capacitor due to the gravitational repulsion of the hyperbolic electron from the Earth as it undergoes a trajectory through the capacitor. A close approximation of the trajectory of hyperbolic electrons generated by the propulsion means of the present invention can be found by solving the Newtonian inverse-square gravitational force equations for the case of a repulsive force. The trajectory follows from the Newtonian gravitational force and the solution of motion in an inverse-square repulsive field given by Fowles [13]. The trajectory can be calculated rigorously by solving the orbital equation from the Schwarzschild metric (Eqs. (26.15-26.16)) for a two-dimensional spatial velocity density function of negative curvature which is produced by the apparatus and repelled by the Earth. The rigorous solution is equivalent to that

given for the case of a positive gravitational velocity given in the Orbital Mechanics Section of Mills [4] except that the gravitational velocity is imaginary, or the gravitational radius is negative.

In the case of a velocity function having negative curvature, Eq. (23.78) becomes

$$\left(1+\frac{2GM}{rc^2}\right)\frac{dt}{d\tau}=\frac{E}{mc^2} \quad (26.79)$$

where $M$ is the mass of the Earth and $m$ is the mass of the hyperbolic electron. Eq. (23.79) is based on the equations of motion of the geodesic, which in the case of an imaginary gravitation velocity or a negative gravitational radius becomes

$$\left(\frac{dr}{d\theta}\right)^2=\frac{r^4}{L_\theta^2}\left[\left(\frac{E}{c}\right)^2-\left(1+\frac{2GM}{c^2 r}\right)\left(\frac{L_\theta^2}{r^2}+m^2c^2\right)\right] \quad (26.80)$$

The repulsive central force equations can be transformed into an orbital equation by the substitution, $u=\frac{1}{r}$. The relativistically corrected differential equation of the orbit of a particle moving under a repulsive central force is

$$\left(\frac{du}{d\theta}\right)^2+u^2=\frac{\left(\frac{E}{c}\right)^2-m^2c^2}{L_\theta^2}-\frac{m^2c^2}{L_\theta^2}\left(\frac{2GM}{c^2}\right)u-\left(\frac{2GM}{c^2}\right)u^3 \quad (26.81)$$

By differentiating with respect to $\theta$, noting that $u=u(\theta)$ gives

$$\frac{d^2u}{d\theta^2}+u=-\frac{GM}{a^2}-\frac{3}{2}\left(\frac{2GM}{c^2}\right)u^2 \quad (26.82)$$

where

$$a=\frac{L_\theta}{m} \quad (26.83)$$

In the case of a weak field,

$$\left(\frac{2GM}{c^2}\right)u \ll 1 \quad (26.84)$$

and the second term on the right-hand of (26.37) can then be neglected in the zero-order. The equation of the orbit is

$$u_0=\frac{1}{r}=A\cos(\theta+\theta_0)-\frac{GM}{a^2} \quad (26.85)$$

$$r=\frac{1}{A\cos(\theta+\theta_0)-\frac{GM}{a^2}} \quad (26.86)$$

where $A$ and $\theta_0$ denote the constants of integration. Consider $E_t$, the sum of the kinetic and gravitational potential energy:

$$E_t = \frac{1}{2}mv^2 + \frac{GMm}{r} \tag{26.87}$$

where $m$ is the mass of the hyperbolic electron. The orbit equation may also be expressed in terms of $E_t$ as given by Fowles [14]

$$r = \frac{\frac{a^2}{GM}}{-1 + \left(1 + \frac{2Ema^2}{(GMm)^2}\right)^{\frac{1}{2}} \cos(\theta - \theta_0)} \tag{26.88}$$

In a repulsive field, the energy is always greater than zero. Thus, the eccentricity $e$, the coefficient of $\cos(\theta - \theta_0)$, must be greater than unity $(e > 1)$ which requires that the orbit must be hyperbolic. Consider the trajectory of a hyperbolic electron shown in FIGURE 8. It approaches along one asymptote and recedes along the other. The direction of the polar axis is selected such that the initial position of the hyperbolic electron is $\theta = 0$, $r = \infty$. According to either of the equations of the orbit (Eq. (26.86) or Eq. (26.88)) $r$ assumes its minimum value when $\cos(\theta - \theta_0) = 1$, that is, when $\theta = \theta_0$. Since $r = \infty$ when $\theta = 0$, then $r$ is also infinite when $\theta = 2\theta_0$. Therefore, the angle between the two asymptotes of the hyperbolic path is $2\theta_0$, and the angle $\phi$ through which the incident hyperbolic electron is deflected is given by

$$\phi = \pi - 2\theta_0 \tag{26.89}$$

Furthermore, the denominator of Eq. (26.88) vanishes when $\theta = 0$ and $\theta = 2\theta_0$. Thus,

$$-1 + \left(1 + \frac{2Ema^2}{(GMm)^2}\right)^{\frac{1}{2}} \cos(\theta_0) = 0 \tag{26.90}$$

Using Eq. (26.89) and Eq. (26.90), the scattering angle $\phi$ is given in terms of $\theta$ as

$$\tan\theta_0 = \frac{(2Em)^{\frac{1}{2}}a}{GMm} = \cot\frac{\phi}{2} \tag{26.91}$$

For convenience, the constant $a = \frac{L_\theta}{m}$ may be expressed in terms of another parameter $p$ called the impact parameter.

The impact parameter is the perpendicular distance from the origin (deflection or scattering center) to the initial line of motion of the hyperbolic electron as shown in FIGURE 8. The relationship between $a$ the angular momentum per unit mass and $v_0$ the initial velocity of the hyperbolic electron is

$$a = |\mathbf{r} \times \mathbf{v}| = pv_0 \tag{26.92}$$

A massive gravitational body such as the Earth will not be moved by the encounter with a hyperbolic electron. Thus, the energy $E_t$ of the deflected hyperbolic electron is constant and is equal to $T$ the initial kinetic energy because the initial potential energy is zero ($r = \infty$).

$$T = \frac{1}{2}mv_0^2 \tag{26.93}$$

Using the impact parameter, the deflection or scattering equation is given by

$$\cot\frac{\phi}{2} = \frac{pv_0^2}{GM} = \frac{2pE}{GMm} \tag{26.94}$$

$$\phi = 2\arctan\left(\frac{pv_0^2}{GM}\right)^{-1} = 2\arctan\left(\frac{2pE}{GMm}\right)^{-1} \tag{26.95}$$

The gravitational velocity of the Earth $v_{g_E}$ is approximately

$$v_{g_E} \approx \sqrt{\frac{2GM}{p}} \tag{26.96}$$

Thus, Eq. (26.95) is given by

$$\phi = 2\arctan\left(\frac{1}{2}\left(\frac{v_{g_E}}{v_0}\right)^2\right) \tag{26.97}$$

Consider the postulate that the hyperbolic electron must follow the trajectory for an inverse squared force in the far field. In the limit, the far field trajectory is the asymptote. As a method to obtain a first approximation of the asymptote, consider the case that the hyperbolic electron is generated at the surface of the Earth with an initial trajectory as shown in FIGURE 8. The initial radial position is $r_{min}$ which is the radius of the Earth. Also, the impact parameter $p$ is essentially equal to the radius of the Earth. Substitution of Eq. (26.87) and Eq. (26.92) into Eq. (26.91) gives

$$\frac{\left(v_0^2+\frac{2GM}{p}\right)^{\frac{1}{2}} p v_0}{GM}=\cot\frac{\phi}{2} \tag{26.98}$$

Substitution of Eq. (26.96) into Eq. (26.98) gives

$$2\left(v_0^2+v_{g_E}^2\right)^{\frac{1}{2}}\frac{v_0}{v_{g_E}^2}=\cot\frac{\phi}{2} \tag{26.99}$$

$$\phi=2\arctan\left(\frac{1}{2}\frac{v_{g_E}^2}{\left(v_0^2+v_{g_E}^2\right)^{\frac{1}{2}}v_0}\right) \tag{26.100}$$

The gravitational velocity of the Earth $v_{g_E}$ is

$$v_{g_E}=\sqrt{\frac{2GM}{R}}=1.1\,X\,10^8\ m/\sec \tag{26.101}$$

where $R$ is the radius of the Earth. Consider the case of the generation of hyperbolic electrons via elastic scattering from helium atoms. Substitution of the hyperbolic electron velocity of $2.187691\,X\,10^6\ m/s$ given by Eq. (26.75) and the gravitational velocity of the Earth given by Eq. (26.101) into Eq. (26.100) gives

$$\phi=2\arctan\left(\frac{1}{2}\frac{\left(1.1\,X\,10^8\ m/\sec\right)^2}{\left(\left(1.1\,X\,10^8\ m/\sec\right)^2+\left(2.2\,X\,10^6\ m/\sec\right)^2\right)^{\frac{1}{2}}\left(2.2\,X\,10^6\ m/\sec\right)}\right) \tag{26.102}$$

The angle of the asymptote is

$$\phi=175^\circ\approx\pi \tag{26.103}$$

Thus, the asymptote of the trajectory of a hyperbolic electron is essentially radial from the Earth. Since the trajectory in a conservative inverse field is reversible going from $+\infty$ to $-\infty$ or vice versa, the entire trajectory of a hyperbolic electron with $v_0=2.187691\,X\,10^6\ m/s$ at $r_{\min}$ equal to the radius of the Earth is essentially radial with respect to the Earth. From this result, it can be concluded that the far field trajectory of a hyperbolic electron formed from a free electron with an initial kinetic energy of $42.3\,eV$ and an initial electron velocity of $2.187691\,X\,10^6\ m/s$ in an arbitrary initial direction relative to

the Earth is essentially radial from the Earth since 1.) $v_0$ is much less than $v_{g_E}$, 2.) the impact parameter is essentially $r_{min}$ which is the radius of the Earth since the radius of the Earth is so large, and 3.) the free electron has zero gravitational mass. The trajectory forms the gravitational boundary condition to be matched with the additional scattering boundary condition.

The scattering distribution of hyperbolic electrons given by Eq. (26.51) is centered at a scattering angle of $\Theta_o$ given by Eq. (26.54). With the condition $z_o = \rho_o$, the elastic electron scattering angle in the far field $\Theta_o$ is determined by the boundary conditions of the curvature of spacetime due to the presence of a gravitating body and the constant maximum velocity of the speed of light. The far field condition must be satisfied with respect to electron scattering and the gravitational orbital equation. The former condition is met by Eq. (26.51) and Eq. (26.54). The latter is met by Eq. (26.103) where the far field angle of the hyperbolic gravitational trajectory $\phi$ is equivalent to $\Theta_o$.

The elastic scattering condition is possible due to the large mass of the helium atom and the Earth relative to the electron wherein the recoil energy transferred during a collision is inversely proportional to the mass as given by Eq. (2.70). Satisfaction of the far field conditions of the elastic electron scattering to produce hyperbolic electrons and the hyperbolic gravitational trajectory requires that the hyperbolic electrons elastically scatter in a direction radially from the Earth with a kinetic energy in the radial direction that is essentially equal to the initial kinetic energy corresponding to the condition $z_o = \rho_o$.

According to Eq. (23.48) and Eq. (23.140), matter, energy, and spacetime are conserved with respect to creation of the hyperbolic electron which is repelled from a gravitating body, the Earth. The gravitationally ejected hyperbolic electron gains energy as it is repelled ($>10^4\ eV$). The ejection of a hyperbolic electron having a negatively curved velocity surface from the Earth must result in an

infinitesimal decrease in its radius of the Earth (e.g. $r$ of the Schwarzschild metric given by Eq. (26.2) where $m_0 = M$ is the mass of the Earth). The amount that the gravitational potential energy of the Earth is lowered is equivalent to the energy gained by the repelled hyperbolic electron.

Momentum is also conserved for the electron, Earth, and helium atom wherein the gravitating body that repels the hyperbolic electron, the Earth, receives an equal and opposite change of momentum with respect to that of the electron.

Causing a satellite to follow a hyperbolic trajectory about a gravitating body is a common technique to achieve a gravity assist to further propel the satellite. In this case, the energy and momentum gained by the satellite is also equal and opposite that lost by the gravitating body.

The kinetic energy of the hyperbolic electron corresponding to a velocity of $2.187691\,X\,10^6\,m/s$ is $T = 42.3\,eV$. Thus, $42.3\,eV$ may be imparted to the propulsion means per hyperbolic electron. With a beam current of $10^5$ amperes achieved in one embodiment by multiple beams such as 100 beams each providing $10^3$ amperes, the power transferred to the device $P_{AG}$ is

$$P_{AG} = \frac{10^5\ \text{coulomb}}{\text{sec}}\ \text{X}\ \frac{1\ \text{electron}}{1.6\ \text{X}\ 10^{-19}\ \text{coulombs}}\ \text{X}\ \frac{42.3\ \text{eV}}{\text{electron}}\ \text{X}\ \frac{1.6\ \text{X}\ 10^{-19}\ \text{J}}{\text{eV}} = 4.2\ \text{MW} \quad (26.104)$$

The power dissipated against gravity $P_G$ is given by

$$P_G = m_c g v_c \quad (26.105)$$

where $m_c$ is the mass of the craft, $g$ is the acceleration of gravity, $v_c$ is the velocity of the craft. In the case of a $10^4\ kg$ craft, the $4.2\ \text{MW}$ of power provided by Eq. (26.104) sustains a steady lifting velocity of $43\ \text{m/sec}$. Thus, significant lift is possible using hyperbolic electrons.

In the case of a $10^4\ kg$ craft, $F_g$, the gravitational force is

$$F_g = m_c g = \left(10^4\ kg\right)\left(9.8\ \frac{m}{\sec^2}\right) = 9.8\ X\,10^4\ N \quad (26.106)$$

where $m_c$ is the mass of the craft and $g$ is the standard gravitational acceleration. The lifting force may be

determined from the gradient of the energy which is approximately the energy dissipated divided by the vertical (relative to the Earth) distance over which it is dissipated. The repulsive gravitational force provided by the hyperbolic electrons may be controlled by adjusting the electric field of the capacitor. For example, the electric field of the capacitor may be increased such that the levitating force overcomes the gravitational force. In an embodiment of the capacitor, the electric field, $E_{cap}$, is constant and is given by the capacitor voltage, $V_{cap}$, divided by the distance between the capacitor plates, $d$, of a parallel plate capacitor.

$$E_{cap} = \frac{V_{cap}}{d} \tag{26.107}$$

In the case that $V_{cap}$ is $10^6\ V$ and $d$ is $1\ m$, the electric field is

$$E_{cap} = \frac{10^6\ V}{m} \tag{26.108}$$

The force of the electric field of the capacitor on a hyperbolic electron, $F_{ele}$, is the electric field, $E_{cap}$, times the fundamental charge

$$F_{ele} = eE_{cap} = \left(1.6\ X\,10^{-19}\ C\right)\left(10^6\ \frac{V}{m}\right) = 1.6\ X\,10^{-13}\ N \tag{26.109}$$

The distance traveled away from the Earth, $\Delta r_z$, by a hyperbolic electron having an energy of $E = 42.3\ eV = 6.77\ X\,10^{-18}\ J$ is given by the energy divided by the electric field $F_{ele}$

$$\Delta r_z = \frac{E}{F_{ele}} = \frac{6.77\ X\,10^{-18}\ J}{1.6\ X\,10^{-13}\ N} = 4.23\ X\,10^{-5}\ m = 0.0423\ mm \tag{26.110}$$

The number of electrons $N_e$ is given by

$$N_e = \frac{I}{e v_e r_i} \tag{26.111}$$

where $I$ is the current, $e$ is the fundamental electron charge, $v_e$ is the hyperbolic electron velocity, $r_i$ is the length of the current. Substitution of $I = 10^5\ A$, $v_e = v_0 = 2.187691\ X\,10^6\ m/s$, and $r_i = 0.2\ m$, the number of electrons is

$$N_e = 1.5\ X\,10^{18}\ \text{electrons} \tag{26.112}$$

The repulsive gravitational force, $F_{AG}$, is given by multiplying the number of electrons (Eq. (26.112)) by the force per

electron (Eq. (26.109)).

$$F_{AG} = N_e F_e = \left(1.5\ X\ 10^{18}\ \text{electrons}\right)\left(1.6\ X\ 10^{-13}\ N\right) = 2.4\ X\ 10^{5}\ N \qquad (26.113)$$

Thus, the present example of a propulsion device may provide a levitating force that is capable of overcoming the gravitational force on the craft to achieve a maximum vertical velocity of 43 m/sec as given by Eq. (26.105). In an embodiment of the propulsion device, the hyperbolic electron current and the electric field of the capacitor are adjusted to control the vertical acceleration and velocity.

Levitation by a repulsive gravitational force is orders of magnitude more energy efficient than conventional rocketry. In the former case, the energy dissipation is converted directly to gravitational potential energy as the craft is lifted out of the gravitation field. Whereas, in the case of rocketry, matter is expelled at a higher velocity than the craft to provide thrust or lift. The basis of rocketry's tremendous inefficiency of energy dissipation to gravitational potential energy conversion may be determined from the thrust equation. In a case wherein external forces including gravity are taken as zero for simplicity, the thrust equation is [15]

$$v = v_0 + V \ln \frac{m_0}{m} \qquad (26.114)$$

where $v$ is the velocity of the rocket at any time, $v_0$ is the initial velocity of the rocket, $m_0$ is the initial mass of the rocket plus unburned fuel, $m$ is the mass at any time, and $V$ is the speed of the ejected fuel relative to the rocket. Owing to the nature of the logarithmic function, it is necessary to have a large fuel to payload ratio in order to attain the large speeds needed for satellite launching, for example.

The repulsive gravitational force of hyperbolic electrons can be increased by using atoms of the neutral atom beam of relativistic kinetic energy. The electrons of the electron beam and the relativistic atoms of the neutral atomic beam intersect at an angle such that the relativistically contracted radius of each atom, $z_o$, is equal to $\rho_o$, the radius of each free electron of the electron beam. Elastic scattering produces hyperbolic electrons at relativistic energies. The relativistic

radius of helium is calculated by substitution of the relativistic mass (Eq. (24.14)) of helium

$$m=\frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (26.115)$$

into Eq. (7.19) with $a_o$ given by Eq. (1.168) where Eq. (26.115) is transformed from Cartesian coordinates to spherical coordinates. In a preferred embodiment, the relativistic atomic beam which intersects the electron beam directed along the negative x-axis is oriented at an angle of $\frac{\pi}{4}$ to both the xz and yz-planes with the relativistic radius of each neutral atom equal to the radius of each free electron.

In another embodiment, high energy hyperbolic electrons are created by scattering according to Eq. (26.75) and Eq. (26.78) from hydrino atoms of small radii. Since hydrino atoms form hydrino hydride ions for $p \leq 24$, hydrino atoms of $p > 24$ are preferably used.

In another embodiment shown in FIGURE 6, hyperbolic electrons are accelerated to relativistic energies by an acceleration means 7 before entering or within the capacitor means 3 to provide relativistic hyperbolic electrons with increased energy to be converted to gravitational potential energy as the body to be levitated is levitated.

In the case of relativistic hyperbolic electrons, the distance traveled in order to transfer a substantial amount of the kinetic energy of the hyperbolic electron to an axis parallel to that of the radius of the Earth is much greater than the case of low hyperbolic electron velocities. With a relativistic hyperbolic electron initially propagating in the direction perpendicular to the radius of the Earth, a path length of many meters may be required for the hyperbolic electron to act on the capacitor. In one embodiment of the propulsion device, a capacitor may further comprise a synchrotron for forcing the hyperbolic electron in a orbit with a component of the velocity in the xy-plane such as that shown in FIGURE 9 which is perpendicular to the radius of

the Earth. The hyperbolic electron held in a synchrotron orbit in the xy-plane is repelled by the Earth and transfers a force to the capacitor in the z direction as shown in FIGURE 9.

In another further embodiment shown in FIGURE 6, hyperbolic electrons of relativistic energy are produced by the scattering of relativistic electrons of the electron beam 8 from the beam of neutrons 9 from the neutron source 12. The relativistic radius of each electron equals the radius, $r_N$, of the neutron given by Eq. (28.10)

$$r_N = \frac{h}{m_N c} \qquad (26.115a)$$

where $m_N$ is the mass of the neutron. The relativistic electron velocity is calculated from Eq. (26.44) and Eq. (26.115a) where the mass of the electron is relativistically corrected by substitution of the mass given by Eq. (26.115) into Eq. (26.44).

$$v_z = \frac{\hbar}{\frac{m_e}{\sqrt{1-\frac{v^2}{c^2}}} r_N} = c\sqrt{\frac{1}{1+\left[2\pi\frac{m_e}{m_N}\right]^2}} = .9999942c \qquad (26.115b)$$

The relativistic kinetic energy, $T$, is

$$T = m_e c^2\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}} - 1\right) \qquad (26.115c)$$

In the case of neutrons with the substitution of Eq. (26.115b) into Eq. (26.115c),

$$T = 149.0273\ MeV \qquad (26.115d)$$

In a further embodiment, electrons from the electron beam 113 of FIGURE 7 having a spatial velocity function having negative curvature are formed by elastic scattering with photons from the photon source 105. The wavelength of each photon and the velocity of each electron is tuned such that the radius of each photon is equal to the radius of each electron. The relationship between the photon radius and wavelength is given by

$$2\pi r_o = \lambda_o \qquad (26.115e)$$

The relationship between the electron radius and velocity is given by Eq. (26.43).

MECHANICS

In addition to levitation, acceleration in a direction tangential to the gravitating body's surface can be effected via conservation of angular momentum. Thus, a radially accelerated structure such as an aerospace vehicle to be tangentially accelerated possesses a cylindrically or spherically symmetrically movable mass having a moment of inertia, such as a flywheel device. The flywheel is rotated by a driving device which provides angular momentum to the flywheel. Such a device is the electron beams which are the source of hyperbolic electrons. The electrons move rectilinearly until being elastically scattered from an atomic beam to form hyperbolic electrons which are deflected in a radial direction from the center of the gravitating body. A component to the initial momentum of the electron beam is transferred to the gravitating body as the hyperbolic electrons are deflected upward by the gravitating body. The opposite momentum is transferred to the source of the electron beam. This momentum may be used to translate the craft in a direction tangential to the gravitating body's surface or to cause it to spin. Thus, the electron beam serves the additional function of a source of transverse or angular acceleration. Thus, it may be considered an ion rocket.

The vehicle is levitated using propulsion means to overcome the gravitational force of the gravitating body where the levitation is such that the angular momentum vector of the flywheel is parallel to the radial or central vector of the gravitational force of the gravitating body. The angular momentum vector of the flywheel is forced to make a finite angle with the radial vector of gravitational force by tuning the symmetry of the levitating forces provided by a propulsion apparatus comprising multiple elements at different spatial locations of the vehicle. A torque is produced on the flywheel as the angular momentum vector is

reoriented with respect to the radial vector due to the interaction of the central force of gravity of the gravitating body, the repulsive gravitational force of the propulsion means, and the angular momentum of the flywheel device. The resulting acceleration which conserves angular momentum is perpendicular to the plane formed by the radial vector and the angular momentum vector. Thus, the resulting acceleration is tangential to the surface of the gravitating body.

Large translational velocities are achievable by executing a trajectory which is vertical followed by a precession with a large radius that gives a translation to the craft. The latter motion is effected by tilting the spinning craft to cause it to precess with a radius that increases due to the force provided by the craft acting as an airfoil. The tilt is provided by the activation and deactivation of multiple repulsive gravitational devices of the present invention spaced so that the desired torque perpendicular to the spin axis is maintained. The craft also undergoes a controlled fall and gains a velocity that provides the centrifugal force to the precession as the craft acts as an airfoil. During the translational acceleration, energy stored in the flywheel is converted to kinetic energy of the vehicle. As the radius of the precession goes to infinity the rotational energy is entirely converted into transitional kinetic energy. The equation for rotational kinetic energy $E_R$ and translational kinetic energy $E_T$ are given as follows:

$$E_R = \frac{1}{2} I\omega^2 \tag{26.116}$$

where $I$ is the moment of inertia and $\omega$ is the angular rotational frequency;

$$E_T = \frac{1}{2} mv^2 \tag{26.117}$$

where $m$ is the total mass and $v$ is the translational velocity of the craft. The equation for the moment of inertia $I$ of the flywheel is given as:

$$I = \sum m_i r^2 \tag{26.118}$$

where $m_i$ is the infinitesimal mass at a distance $r$ from the center of mass. Eqs. (26.116) and (26.118) demonstrate that the rotational kinetic energy stored for a given mass is maximized by maximizing the distance of the mass from the center of mass. Thus, ideal design parameters are cylindrical symmetry with the rotating mass, flywheel, at the perimeter of the vehicle.

The equation that describes the motion of the vehicle with a moment of inertia $I$, a spin moment of inertial $I_s$, a total mass $m$, and a spin frequency of its flywheel of $S$ is given as follows [16]:

$$mgl\sin\theta = I\ddot{\theta} + I_s S\dot{\phi}\sin\theta - I\dot{\phi}^2\cos\theta\sin\theta \tag{26.119}$$

$$0 = I\frac{d}{dt}\left(\dot{\phi}\sin\theta\right) - I_s S\dot{\theta} + I\dot{\theta}\dot{\phi}\cos\theta \tag{26.120}$$

$$0 = I_s\dot{S} \tag{26.121}$$

where $\theta$ is the tilt angle between the radial vector and the angular momentum vector, $\ddot{\theta}$ is the acceleration of the tilt angle $\theta$, $g$ is the acceleration due to gravity, $l$ is the height to which the vehicle levitates, and $\dot{\phi}$ is the angular precession frequency resulting from the torque which is a consequence of tilting the craft. Eq. (26.121) shows that $S$, the spin of the craft about the symmetry axis, remains constant. Also, the component of the angular momentum along that axis is constant.

$$L_z = I_s S = \text{constant} \tag{26.122}$$

Eq. (26.120) is then equivalent to

$$0 = \frac{d}{dt}\left(I\dot{\phi}\sin^2\theta + I_s S\cos\theta\right) \tag{26.123}$$

so that

$$I\dot{\phi}\sin^2\theta + I_s S\cos\theta = B = \text{constant} \tag{26.124}$$

The craft is an airfoil which provides the centrifugal force to move the center of mass of the craft away from the Z axis of the stationary frame. The schematic appears in FIGURE 10.

If there is no drag acting on the spinning craft to dissipate its energy $E$, then the total energy $E$ equal to the kinetic $T$ and potential $V$ remains constant:

$$\frac{1}{2}\left(I\omega_x^2 + I\omega_y^2 + I_s S^2\right) + mgl\cos\theta = E \tag{26.125}$$

or equivalently in terms of Eulerian angles,

$$\frac{1}{2}\left(I\dot{\theta}^2 + I\dot{\phi}^2 \sin^2\theta + I_s S^2\right) + mgl\cos\theta = E \qquad (26.126)$$

From Eq. (26.124), $\dot{\phi}$ may be solved and substituted into Eq. (26.126). The result is

$$\frac{1}{2}I\dot{\theta}^2 + \frac{\left(B - I_s S\cos\theta\right)^2}{2I\sin^2\theta} + \frac{1}{2}I_s S^2 + mgl\cos\theta = E \qquad (26.127)$$

which is entirely in terms of $\theta$. Eq. (26.126) permits $\theta$ to be obtained as a function of time $t$ by integration. The following substitution may be made:

$$u = \cos\theta \qquad (26.128)$$

Then

$$\dot{u} = -(\sin\theta)\dot{\theta} = -\left(1 - u^2\right)^{1/2}\dot{\theta} \qquad (26.129)$$

Eq. (26.127) is then

$$\dot{u}^2 = \left(1 - u^2\right)\left(2E - I_s S^2 - 2mglu\right)I^{-1} - \left(B - I_s Su\right)^2 I^{-2} \qquad (26.130)$$

or

$$\dot{u}^2 = f(u) \qquad (26.131)$$

from which $u$ (hence $\theta$) may be solved as a function of $t$ by integration:

$$t = \int \frac{du}{\sqrt{f(u)}} \qquad (26.132)$$

In Eq. (26.132), $f(u)$ is a cubic polynomial, thus, the integration may be carried out in terms of elliptic functions. Then the precession velocity $\dot{\phi}$ may be solved may be solved by substitution of $\theta$ into Eq. (26.124) wherein the constant $B$ is the initial angular momentum of the craft along the spin axis, $I_s S$ given by Eq. (26.122). The radius of the precession is given by

$$R = l\sin\theta \qquad (26.133)$$

And the linear velocity $v$ of the precession is given by

$$v = R\dot{\phi} \qquad (26.134)$$

The maximum rotational speed for steel is approximately $1100\ m/\text{sec}$ [17]. For a craft with a radius of $10\ m$, the corresponding angular velocity is $\frac{110\ cycles}{\text{sec}}$. In the case that most of the mass of a $10^4\ kg$ was at this radius, the initial

rotation energy (Eq. (26.116)) is $6 X 10^9 J$. As the craft tilts and changes altitude (increases or decreases), the airfoil pushes the craft away from the axis that is radial with respect to the Earth. For example, as the craft tilts and falls, the airfoil pushes the craft into a trajectory which is analogous to that of a gyroscope as shown in FIGURE 10. From FIGURE 10, the centrifugal force provided by the airfoil ($mg\cos\theta$) is always less than the force of gravity on the craft. From Eq. (26.124), the rotational energy is transferred from the initial spin to the precession as the angle $\theta$ increases. From Eq. (26.125), the precessional energy may become essentially equal to the initial rotational energy plus the initial gravitational potential energy. Thus, the linear velocity of the craft may reach approximately $1100\ m/\sec$ ($2500\ mph$). During the transfer, the craft falls approximately one half the distance of the radius of the precession of the center of mass about the Z axis. Thus, the initial vertical height $l$ must be greater.

In the cases of solar system and interstellar travel, velocities approaching the speed of light may be obtained by using gravity assists from massive gravitating bodies wherein the capability of the craft to provide a repulsive gravitational force establishes the desired trajectory to maximize the assist.

## EXPERIMENTAL

The electron-impact energy-loss spectrum of helium taken in the forward direction with $100\ eV$ incident electrons with a resolution of $0.15\ eV$ by Simpson, Mielczarek, and Cooper [18] showed large energy-loss peaks at $57.7\ eV$, $60.0\ eV$, and $63.6\ eV$. Resonances in the photoionization continuum of helium at $60\ eV$ and in the $63.6\ eV$ region have been observed spectroscopically by Madden and Codling [19] using synchrotron radiation. Absent was a resonance at $57.7\ eV$. Both Simpson and Madden assign the peaks of their data to two-electron excitation states in helium. Each of these states decays with the emission of an ionization electron of energy

equal to the excitation energy minus the ionization energy of helium, $24.59\,eV$. The data of Goruganthu and Bonham [20] shows ejected-energy peaks at $35.5\,eV$ and at $39.1\,eV$ corresponding to the energy loss peaks of Simpson of $60.0\,eV$ and $63.6\,eV$, respectively. The absence of an ejected-energy peak corresponding to the energy-loss peak at $57.7\,eV$ precludes the assignment of this peak to a two-electron resonance. The energy of each inelastically scattered electron of incident energy of $100\,eV$ corresponding to the energy-loss of $57.7\,eV$ is $42.3\,eV$. This is the resonance energy of hyperbolic electron production by electron scattering from helium given by Eq. (26.77). Thus, the $57.7\,eV$ energy-loss peak of Simpson arises from inelastic scattering of electrons of $42.3\,eV$ from helium with resonant hyperbolic electron production. The production of electrons with velocity functions having negative curvature is experimentally supported.

The electron-impact energy-loss spectrum of helium taken in the forward direction with $400\,eV$ incident electrons by Priestley and Whiddington [21] showed large energy-loss peaks at $42.4\,eV$, and $60.8\,eV$. A resonance in the photoionization continuum of helium at $60\,eV$ has been observed spectroscopically by Madden and Codling [19] using synchrotron radiation. Absent was a resonance at $42.4\,eV$. Both Priestley and Madden assign the peaks of their data to two-electron excitation states in helium. Each of these states decay with the emission of an ionization electron of energy equal to the excitation energy minus the ionization energy of helium, $24.59\,eV$. The data of Goruganthu and Bonham [20] shows an ejected-energy peak at $35.5\,eV$ corresponding to the energy loss peak of Priestley of $60.8\,eV$. The absence of an ejected-energy peak at $17.8\,eV$ corresponding to the energy-loss peak at $42.4\,eV$ precludes the assignment of this peak to a two-electron resonance. This is the resonance energy of hyperbolic electron production by electron scattering from helium given by Eq. (26.77). Thus, the $42.4\,eV$ energy-loss peak of Priestley arises from inelastic scattering of electrons

of $42.3\ eV$ from helium with resonant hyperbolic electron production. The production of electrons with velocity functions having negative curvature is experimentally further supported.

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